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30ID Beamline Requirements Document for the Generation-3 Personnel Safety System (PSS) of the Advanced Photon Source at Argonne National Laboratory 9700 Cass Avenue Argonne, Illinois 60439

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Approved By:

John Carwardine, Associate Division Director, Electrical Systems, ASD	Date
, Group Leader, SI, ASD	Date
Mohan Ramanathan, Chairman, Adhoc Gen-3 PSS committee	Date
Jim Lang, Radiation Safety	Date

Prepared By:

Anne Boron,
SI, ASD — Date

Reviewed By:

Roy Emerson,
SI, ASD — Date

Jon Hawkins,
SI, ASD — Date

Martin Knott,
ESS, ASD — Date

Mike Fagan,
SI, ASD — Date

Nick Friedman,
SI, ASD — Date

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1. Introduction

1.1 Beamline Requirements Document Purpose

This document establishes user requirements for items which affect the APS Beamline Personnel Safety System. These user requirements are specific to a given CAT and will be used to implement both the PSS hardware and software for that CAT. It also provides a general PSS specification to the user community.

1.2 Definitions, acronyms, and abbreviations

The following are some of the frequently appearing or unique acronyms used in this document. This list is provided as a quick reference for the reader's convenience.

ACIS	Access Control Interlock System
APS	Advanced Photon Source
ASD	Accelerator Systems Division
BLEPS	Beamline Equipment Protection System
CPU	Central Processing Unit
C&C	Command and Control
DIW	De-Ionized Water
DOE	Department Of Energy
EPICS	Experimental Physics and Industrial Control System
EPS	Equipment Protection System
ES&H	Environment, Safety & Health Manual
ESD	Emergency Shut Down
FEEPS	Front End Equipment Protection System
FOE	First Optics Enclosure
I/O	Input Output
IOC	Input Output Controller (data collection for EPICS)
LAN	Local Area Network
OI	Operator Interface
PSS	Personnel Safety System
PLC(s)	Programmable Logic Controller(s)
PMD	Programmable Message Display
SAD	Safety Assessment Document
SDD	Software Design Document
SyRS	System Requirements Specification
TBD	To Be Defined/Decided
VME	Versa Module Eurocard
XFD	Experimental Facilities Division

1.3 References

The following documents form a part of this functional description to the extent specified herein. In the event of conflict between the documents referenced herein ant the contents of this functional description, the contents of this functional description shall be considered a superseding functional description.

Government Documents:

Department of Energy (DOE) ORDER 420.2A, 01-08-01
Accelerator Safety Implementation Guide for DOE O 420.2A, Draft, August 2001
DOE ORDER 5480.25, 11-3-92
DOE GUIDANCE 5480.25, September 1, 1993

DOE ORDER and GUIDANCE 5480.25 are included because they were in effect and referenced when the Safety Assessment Document (SAD) was originally written; it has been superseded by DOE ORDER 420.2, which has been superseded by DOE ORDER 420.2A. DOE ORDER 420.2(A) essentially made the approved SAD the effective regulatory document.

Copies of specifications, standards, drawings and publications required by suppliers in connection with specified procurement functions should be obtained from the contracting agency or as directed by the contracting office.

Non-Government Documents
The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.
Environment Safety & Health Manual, Section 5.16 (ES&H 5.16) April 25, 2003, Argonne National Laboratory.
APS Safety Assessment Document (SAD), Rev 1, May 1999, Argonne National Laboratory, Argonne, IL.

Compliance with the following required by SAD:
Stanford Linear Accelerator Center Report 327 (SLAC 327), April 1988, Stanford Linear Accelerator Center, Menlo Park, CA.
National Council on Radiation Protection Report No. 88 (NCRP 88), Issued 30 December 1986, National Council on Radiation Protection.
Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal Agencies.

Document No. 1111-00001-00 APS Quality Assurance Plan, dated May 1990.

2.0 Definition, Policy, and Responsibility

The definition, policy, and responsibility sections listed below are provided as broad guidelines to establish the user requirements.

2.1 System Overview

The Personnel Safety System (PSS) is the access control and safety interlock system for the enclosures (stations) of the synchrotron radiation (X-ray) beamlines, of the Advanced Photon Source, at Argonne National Laboratory. Its function is to prevent personnel injury from synchrotron radiation hazards associated with the operation of a beamline. It also incorporates control functions for operation of the beamline.

2.2 Definition

The APS PSS is a high reliability, fail-safe, redundant, stand-alone system that carefully monitors and controls personnel access into potentially hazardous Experimental Stations and inhibits or reduces the hazard to mitigate harm to personnel. The only hazards in the experimental area of the APS which the system is designed to guard against are the direct X-ray radiation from the APS. These hazards are inhibited by controlling beam stops or by aborting the Storage Ring beam.

The system's responsibility is first and foremost safety, but significant attention is given to meeting user requirements and ergonomic issues relating to the system's use. The system is not intended to provide security.

2.3 Policy

The APS/ASD will design, install, commission, and maintain the PSS. The PSS is a sensitive system that has additional requirements due to its nature. Therefore, users are not allowed to perform any work on the PSS and not tamper with this equipment. Refer to APS Revision 1 Safety Assessment Document (May 1999) for further clarification. It is also the policy of the APS/ASD to test this system every 12 months.

Within the scope of the definition in section xx above, and other mandates imposed by APS, DOE or other organizations with authority to regulate, the user requirements contained in this document are in compliance with an approved Beamline Final Design Report (FDR) as defined in section xx above.

2.4 Responsibility

It shall be the responsibility of the user to provide sufficient information at reviews and subsequent PSS meetings to ascertain the adequacy of the beamline design with particular attention focused on showing that user designs do not adversely affect the operation of the PSS.

3. System Description for Typical PSS

The following is a brief description of the Personnel Safety System. Numerous other documents will be available such as operating manuals and search and secure procedures to provide additional in depth information.

3.1 Door Interlocks

All personnel access doors into an experimental station will be interlocked and monitored such that in the event any door is open, beam to that station will be inhibited. Door closed position is monitored by redundant, dissimilar switches.

3.2 Search and Secure

All experimental stations must be searched and secured to insure that personnel are not located within the enclosure during beam running periods. The search sequence is enforced by the PSS.

3.3 Global On-Line Mode

A Global On-line Mode will exist during normal running periods. The PSS may be brought off-line during down periods or extensive repair periods. This is accomplished by a special "key" that must be inserted into a special ACIS/PSS cabinet located in the control room above the storage ring. Users will not have access to this key.

3.4 User Control

The PSS will provide, on the experimental floor, a means to control critical safety devices and automatic station doors in the beamline. The Beamline PSS OI Terminals are the primary means to control safety related devices and are used during each access. Station door operation and open/closed status is provided by Door Controller Panels and Door Control Boxes. If different beam modes are required then a Mode Controller Panel is provided. Appendix A illustrates CAT specific PSS OI Terminals. Every attempt has been made to provide an easy to use access controller and system in general.

3.5 Operator Interface

The primary means for human interface with the PSS are the OI Terminals which consists of simple programmed control switches and LED indicators on the OI Terminals. Additional in-depth information regarding the PSS will be provided by EPICS screens run on workstations.

3.6 Faults

OI Terminals provide fault status(i.e. Minor, Serious or Major Faults) and a means to reset faults.

4. Experimental Station and Beamline APS Requirements

The experimental stations represent a major component of the PSS. The PSS interlocks station door operation, provides for emergency egress, enforces a logical search sequence of the area, provides audible and visual alarms and numerous other features to insure the safety of personnel. Toward this end, there are APS/ASD personnel safety requirements that must be met to insure that the effectiveness of the PSS is not affected by user equipment, systems, subsystems, etc.

4.1 Audible and Visual Warnings

Audible and visual alarms are installed in the experimental station to warn personnel of potentially dangerous events; typically that the area will be secured and that personnel within the enclosure must vacate. User equipment located inside the experimental station must not interfere with the effectiveness of these alarms.

4.2 Accessibility and Visibility

Every attempt has been made to install PSS equipment where it is easily visible and easy to operate. User equipment must not interfere with accessibility to PSS equipment. Inside non-monochromatic experimental stations the downstream wall within 1 meter of the beam path is considered an equipment free zone.

The number and location of PSS emergency beam abort buttons inside an experimental station depends on the size and geometry of each station in addition to accessibility inside the station. A two foot diameter equipment free zone around each PSS emergency beam abort button is required, wherever these buttons are located.

The number and location of PSS Search and Secure boxes at a given experimental station depends of the size and geometry of each station in addition to accessibility inside the station. There should be an equipment free zone (i.e. no other equipment within 2 feet) around each Search and Secure box. **The general criteria for the locating Search boxes is to force a uni-directional sweep of the area being secured, such that line of sight is provided to all spaces that could be occupied by a human. The search must end outside the station.**

4.3 Cable and Wireways

The PSS has its own dedicated cable tray and wireway. User cables must not use the PSS dedicated tray or wireway.

4.4 Radiation Critical Devices

Designers of the beamline must provide for the installation of devices that can inhibit a beamline during accesses. Since all aspects of the safety system are redundant, two such devices must be implemented. Note that these devices must be dedicated strictly for the PSS and may not be used for any non-safety purpose. All non-monochromatic critical device beam stops in ID beamlines must have redundant coolant signals that will be interlocked to the PSS only as per APS/ASD policy.

References

Government Documents

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APS Safety Assessment Document (SAD), Rev 1, May 1999, Argonne National Laboratory, Argonne, IL, Laboratory Prototype Requirements Document, March, 2004, Argonne National Laboratory, Argonne, IL.

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5. Experimental Station and Beamline User Requirements

The experimental stations represent a major component of the PSS. The PSS interlocks station door operation, provides for emergency egress, enforces a logical search sequence of the area, provides audible and visual alarms and numerous other features to insure the safety of personnel. Toward this end, there are CAT specific operational requirements that must be met to insure safe and effective beamline operation.

5.1 CAT Specific Operational Requirements

(See Appendix A)

5.2 CAT Specify PSS Controller Panels

(See Appendix B)

5.3 CAT Specific Experimental Station Configuration

(See Appendix C)

APPENDIX A

Beamline Sector 30 Insertion Device

SPECIAL INFORMATION

- Beamline contains Station A, B, C, a P5B Shutter in Station A to protect Station B, and a P8C shutter in Station B which protects Station C.
- This Beamline will contain a Version 3 PSS system.
- This Beamline has a High Heat Load Front End. No changes to standard PSS equipment or logic are necessary for this front end.
- Flow and DP will be monitored in Station A for the P5B.
- PSS PLC hardware cabinets will be located both on the mezzanine (Front End Relay Distribution Panel) and on the station walls of the individual hutches (remote I/O for control of hutch elements)
- An EPICS interface will serve as the primary means of controlling PSS elements within this beamline.
- The FERDP located on the mezzanine will contain these components as they relate to the three PLC control chains:
  - Chain A: Allen Bradley Control Logix PLC.
  - Chain B: GE 9030 PLC
  - Chain C: Allen Bradley Control Logix PLC
- Chain A PLC logic will contain search sequences as well as ESD control
- Chain B PLC logic will contain only ESD control.
- Chain C PLC logic will house all command and control functionality with the exception of search and secure sequences contained in Chain A.
- The three PLC chains will communicate by means of Profibus communications protocol.

PSS Beamline Truth Tables

- Reference documents for the beamline are:

Document	Chain A Version	Chain B Version	Chain C Version	Dated
Software Change Request				
I/O List				
Fault List				

- Station protection Critical Devices:

Configuration	Station A	Station B	Station C
N/A	FES	P5B	P8C

- Shutter Beam Ready interlocks to allow Shutter to open:

Configuration	FES Shutter	P5B	P8C
N/A	Station A Beam Ready and FES FEEPS Permits	Station A Beam Active and P5B open Logic	Station C Beam Ready and P8C BLEPS Permits

- Station Beam Active:

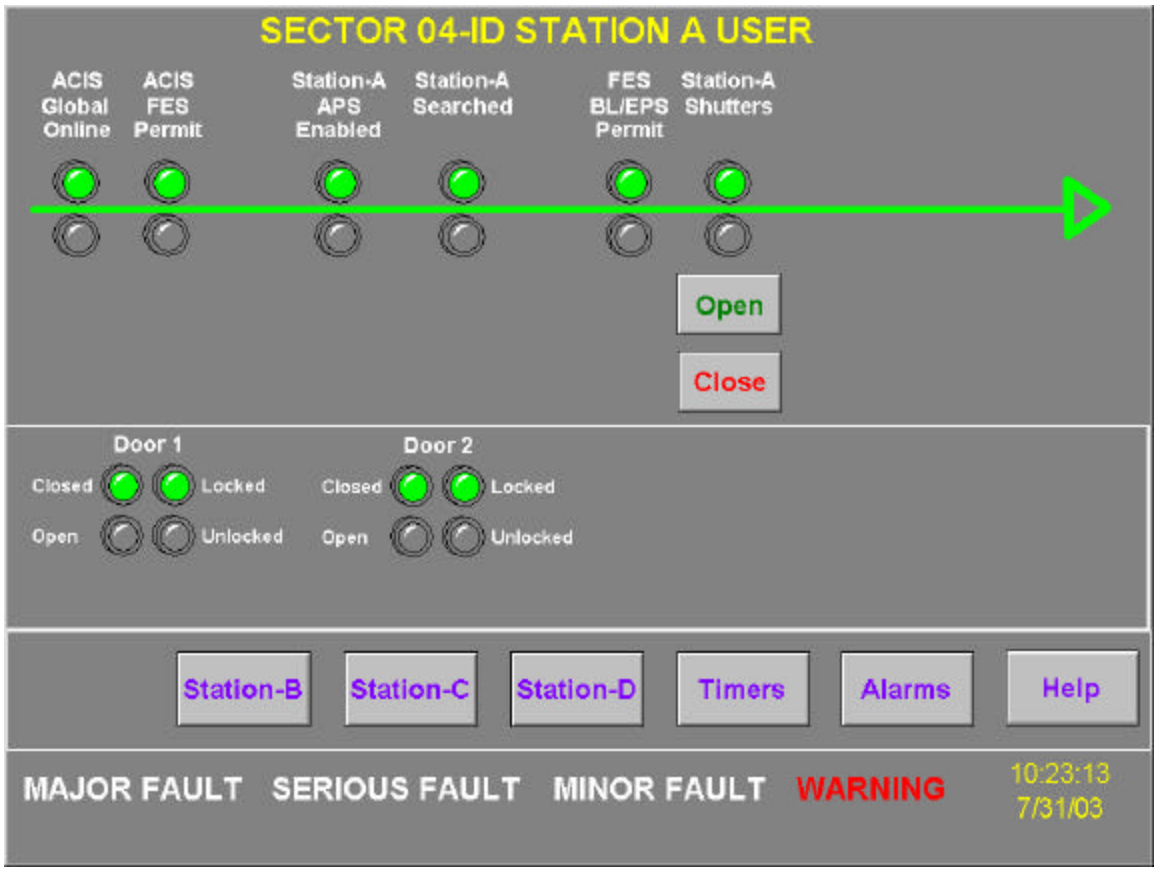
Configuration	Station A Beam Active	Station B Beam Active	Station C Beam Active
N/A	FES NOT Closed Logic	Station A Beam Active and P5B open Logic	Station B Beam Active and P8C open Logic

- FES Major Faults Path Logic:

Configuration	FES Major Faults 50-58 Logic
N/A	Station A not searched and Shutter PS1 open

- **Any questions may be answered by contacting the PSS System Engineer or the Document Author as listed on Page 2..**

PSS Control Panel Station A



A User Control Panel similar to the above will be used for each station as an interface to the hardware input devices. Panels will be customized to specific user needs.

Station A Sample User Panel Operation

The User Control Panel indicators for a typical Station A panel operate as follows:

- ACIS GLOBAL ONLINE
  - Green LED — This Indicator light will be on when the Global On-Line signal is high (+24 volts).
  - Red LED — This Indicator light will be on when the Global On-Line signal is low (0 volts).
- ACIS FES PERMIT
  - Green LED — This Indicator light will be on when the ACIS signal is high (+24 volts).
  - Red LED — This Indicator light will be on when the ACIS signal is low (0 volts).
- APS ENABLE
  - Green LED — This Indicator light will be on when the APS floor coordinator toggles the APS key switch to enable the station for beam.
  - Red LED — This Indicator light will be on when the APS floor coordinator toggles the APS key switch to disable the station for beam.
- SEARCHED
  - Green LED — This Indicator light will be on when the Station is searched. This signal is high (+24 volts) and is provided to Chains B and C.
  - Red LED — This Indicator light will be on when the Station is searched signal is low (0 volts) from Chain A.
- FE EPS PERMIT
  - Green LED — This Indicator light will be on when the FEEPS FEPERM signal is high (+24 volts).
  - Red LED — This Indicator light will be on when the FEEPS FEPERM signal is low (0 volts).
- SHUTTER OPEN
  - Green LED — This Indicator light will be on when the Front End Shutters (FES) are not closed. This not closed condition is based upon SS1 not closed or SS2 not closed or (PS2 not closed and PS1 not closed) or (SS1, SS2, PS1 and PS2 permits on).
  - Red LED — This Indicator light will be on when the (SS1 and SS2) and (PS1 or PS2) closed limit switch signals are high (+24 volts).

Note: All Panel Indicator lights take their signal from Chain C. Statuses from Chains A and B are routed through Chain C.

- DOOR INDICATORS

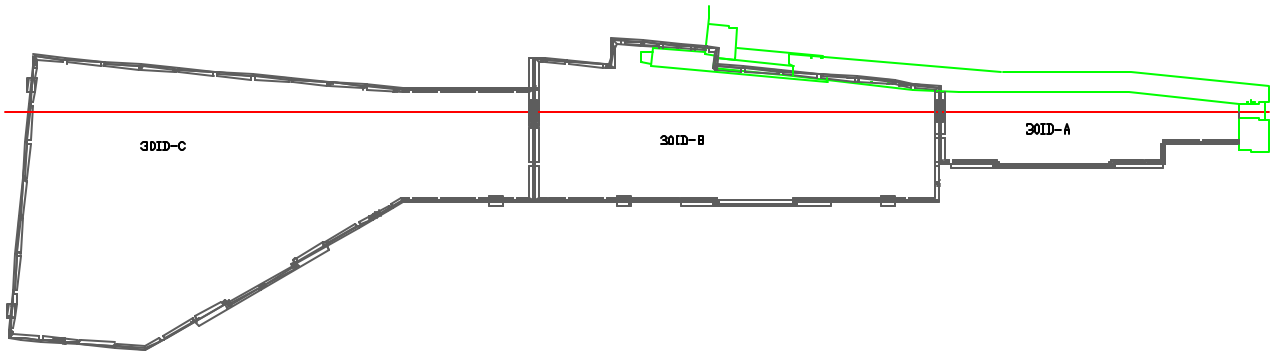
Closed	This Indicator light will be on when the corresponding door has actuated the door closed limit switch.
Open	This Indicator light will be on when the corresponding door closed limit switch is NOT activated.
Locked	This Indicator light will be on when the corresponding door lock has been actuated and is locked.
Unlocked	This Indicator light will be on when the corresponding door lock is not actuated and the door is not locked.

- FAULT INDICATORS

Major Fault	This Indicator will be on when a major fault exists in the PSS fault stack.
Serious Fault	This Indicator will be on when a serious fault exists in the PSS fault stack.
Minor Fault	This Indicator will be on when a minor fault exists in the PSS fault stack.
Warning	This Indicator will be on when a warning condition exists in the PSS.

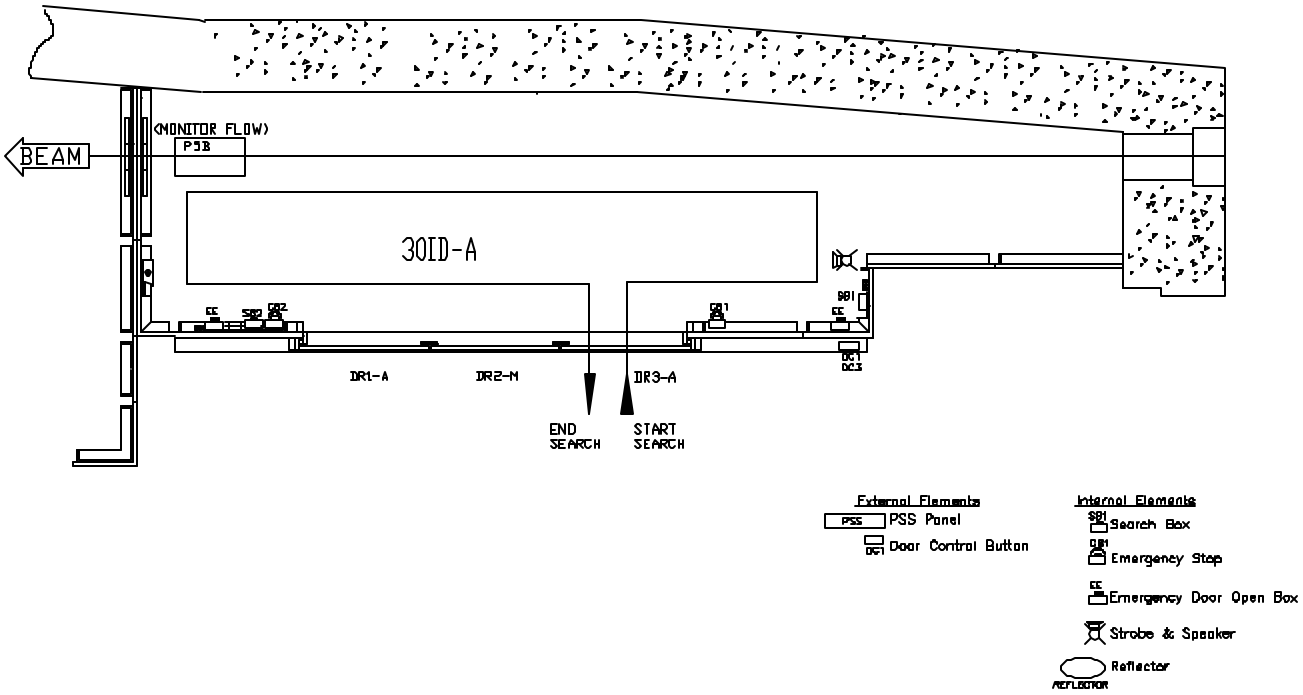
APPENDIX C

Station Overview



- Stations B and C will be Mono Beam stations. Station A will have White (Non-Mono) Beam.

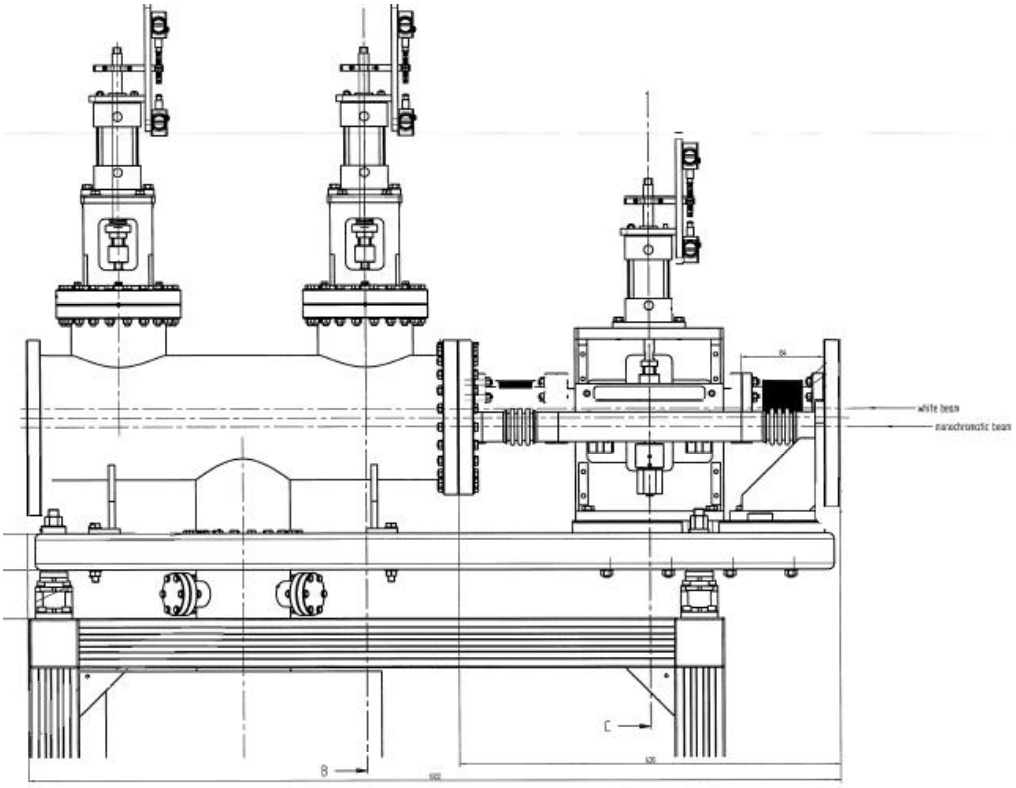
Station A Detail



Initial Search Conditions: DR1 Open
Search Sequence: SB1-SB2-DR1
Door Interlocks: N/A
Search Time: 90 Seconds

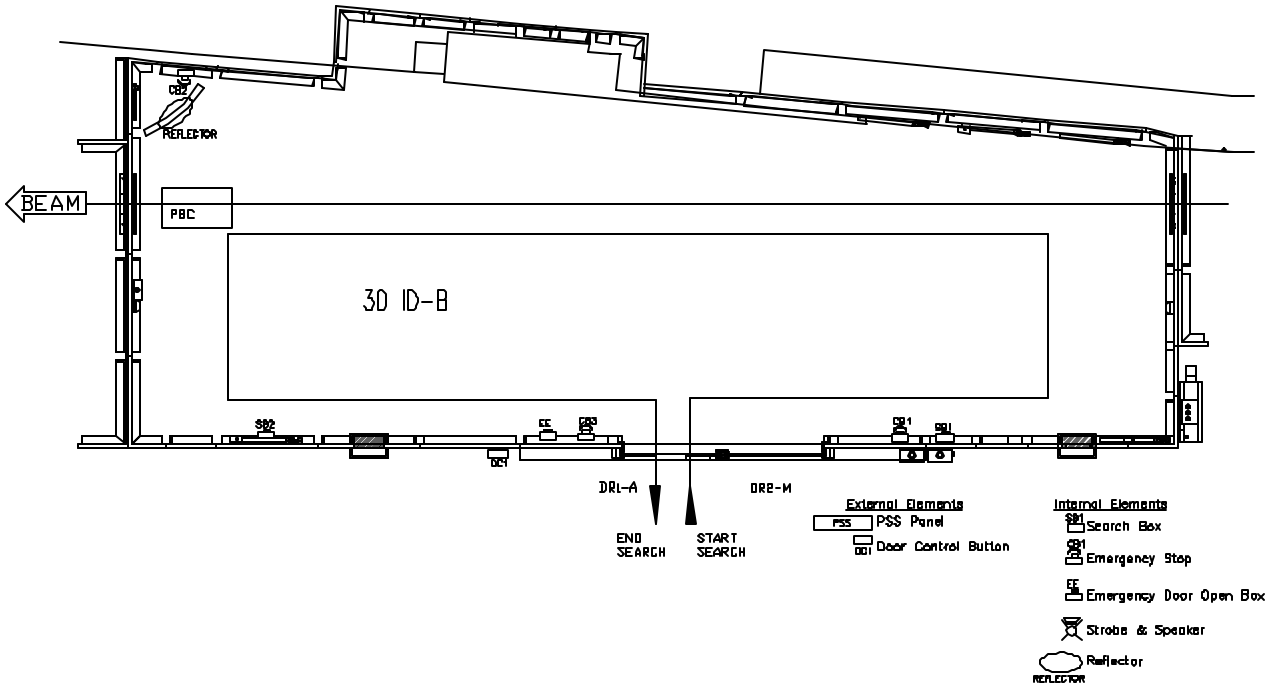
- The P5B will have cooling flow and DP.

P5B Shutter Detail



- A detailed photo of any integral shutter(s) protecting the station will appear directly before the station detail drawings.
- Both Cooling Flow and DP will be monitored for this shutter.

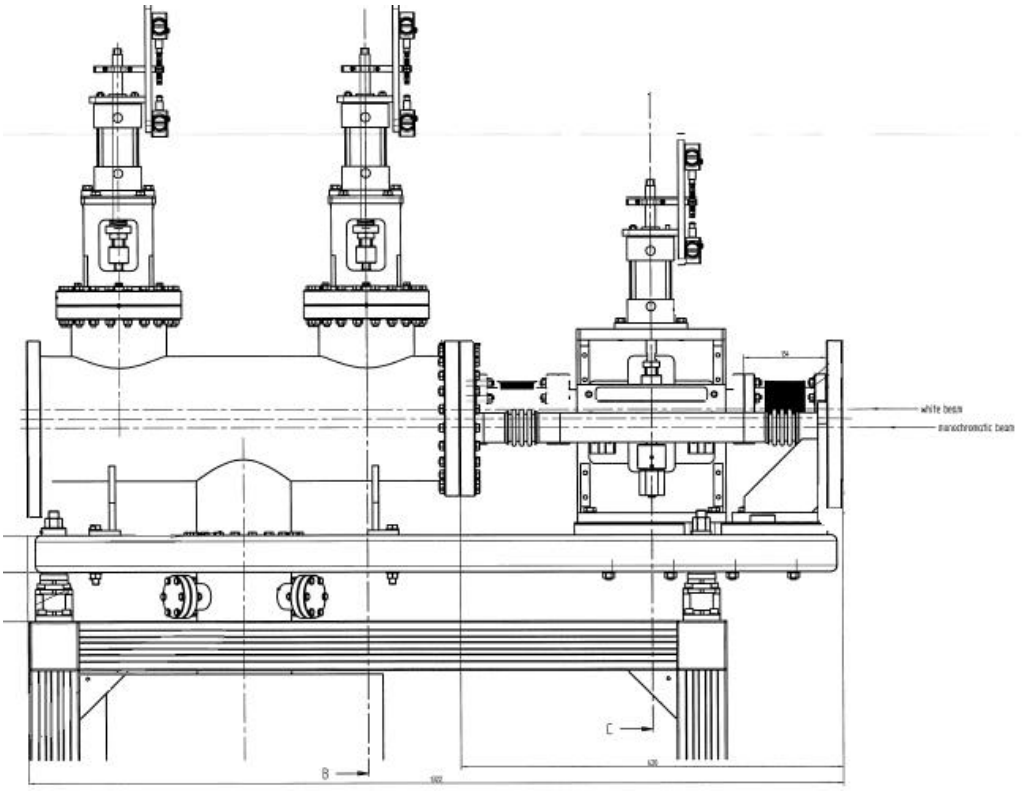
Station B Detail



Initial Search Conditions: DR1 Open
Search Sequence: SB1-SB2-DR1
Door Interlocks: N/A
Search Time: 90 Seconds

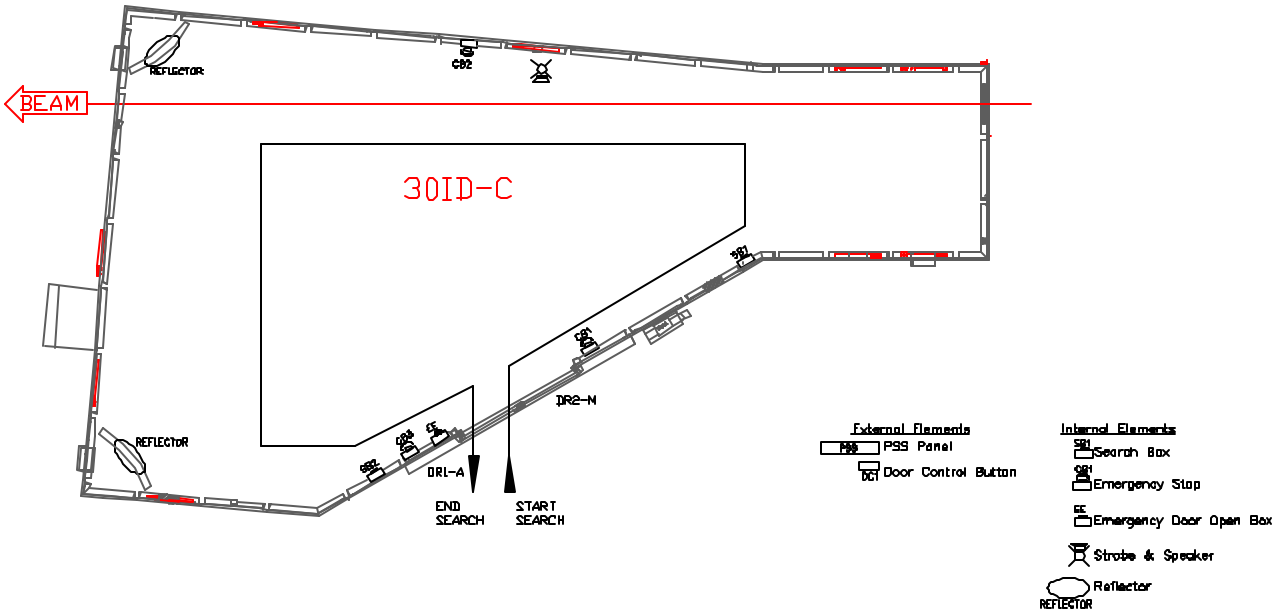
- Station B will be a mono beam station.

P8C Shutter Detail



A detailed photo of any integral shutter(s) protecting the station will appear directly before the station detail drawings.

Station C Detail



Initial Search Conditions: DR1 Open
Search Sequence: SB1-SB2-DR1
Door Interlocks: N/A
Search Time: 90 Seconds

- Station C will be a mono beam station.